REMARKS

Claims 1-20 are pending in the application.

It is believed that this Amendment is fully responsive to the Office Action dated January 29, 2003.

Claim of Priority under 35 USC § 119

At the outset, it should be noted that the Examiner has not acknowledged claim of priority under 35 USC § 119. It is requested that the Examiner acknowledge the claim of priority in this particular application.

Claim Rejections under 35 USC §102

Claims 1-3, 7-10, 13 and 16 are rejected under 35 USC §102(b) as being clearly anticipated by Ha et al. (U.S. 6,493,051).

At the outset, it should be noted that Ha et al. issued as a Patent on December 10, 2002 and was filed on December 6, 2000. The present application was filed on July 20, 2001 and claims priority to Japanese application number 2000-220116, filed on the July 21, 2000. Under MPEP §201.15, it is possible to overcome a reference with a priority date if a certified translation of the priority document is supplied to the U.S. Patent and Trademark Office. Such a certified translation of Japanese application number 2000-220116 is herewith attached to this amendment. Therefore, the priority date is established as July 21, 2000 which is before the filing date of Ha et al. Thus, Ha et al. may not be used as prior art.

Therefore, withdrawal of the rejection of Claims 1-3, 7-10, 13 and 16 under 35 USC §102(b) as being clearly anticipated by Ha et al. (U.S. 6,493,051) is respectfully requested.

Claims 1, 5, 10 and 13 are rejected under 35 USC §102(e) as being clearly anticipated by Urabe et al. (U.S. Patent No. 6,476,889).

At the outset, it should be noted that Urabe et al. issued as a Patent on November 5, 2002 and was filed on December 12, 2000. The present application was filed on July 20, 2001 and claims priority to Japanese application number 2000-220116, filed on the July 21, 2000. Under MPEP §201.15, it is possible to overcome a reference with a priority date if a certified translation of the priority document is supplied to the U.S. Patent and Trademark Office. Such a certified translation of Japanese application number 2000-220116 is herewith attached to this amendment. Therefore, the priority date is established as July 21, 2000 which is before the filing date of Urabe et al. Thus, Urabe et al. may not be used as prior art.

Therefore, withdrawal of the rejection of Claims 1, 5, 10 and 13 under 35 USC §102(e) as being clearly anticipated by Urabe et al. (U.S. Patent No. 6,476,889) is respectfully requested.

Claims 1-2, 5, 10, 13, 14, 16 and 18-20 are rejected under 35 USC §102(e) as being clearly anticipated by Urabe et al. (U.S. Patent No. 6,476,889).

Again it should be noted that Urabe et al. issued as a Patent on November 5, 2002 and was filed on December 12, 2000. The present application was filed on July 20, 2001 and claims priority to Japanese application number 2000-220116, filed on the July 21, 2000. Under MPEP § 201.15, it

is possible to overcome a reference with a priority date if a certified translation of the priority document is supplied to the U.S. Patent and Trademark Office. Such a certified translation of Japanese application number 2000-220116 is herewith attached to this amendment. Therefore, the priority date is established as July 21, 2000 which is before the filing date of Urabe et al. Thus, ~~Urabe et al. may not be used as prior art.~~

Therefore, withdrawal of the rejection of Claims 1, 5, 10 and 13 under 35 USC §102(e) as being clearly anticipated by Urabe et al. (U.S. Patent No. 6,476,889) is respectfully requested.

Claim Rejections under 35 USC §103

Claims 4, 5-6, 11-12, 15 and 17-20 are rejected under 35 USC §103(a) as being unpatentable over Ha et al. as applied to claims 1-3, 7-10, 13 and 16 above.

Again it should be noted that Ha et al. issued as a Patent on December 10, 2002 and was filed on December 6, 2000. The present application was filed on July 20, 2001 and claims priority to Japanese application number 2000-220116, filed on the July 21, 2000. Under MPEP § 201.15, it is possible to overcome a reference with a priority date if a certified translation of the priority document is supplied to the U.S. Patent and Trademark Office. Such a certified translation of Japanese application number 2000-220116 is herewith attached to this amendment. Therefore, the priority date is established as July 21, 2000 which is before the filing date of Ha et al. Thus, Ha et al. may not be used as prior art.

Therefore, withdrawal of the rejection of Claims 4, 5-6, 11-12, 15 and 17-20 under 35 USC §103(a) as being unpatentable over Ha et al. is respectfully requested.

Claims 2-3, 6-9, 11-12 and 14-20 are rejected under 35 USC '103(a) as being ~~unpatentable over Urabe as applied to claims 1, 5, 1 and 13 (per Figure 1) above.~~

Again it should be noted that Urabe et al. issued as a Patent on November 5, 2002 and was filed on December 12, 2000. The present application was filed on July 20, 2001 and claims priority to Japanese application number 2000-220116, filed on the July 21, 2000. Under MPEP § 201.15, it is possible to overcome a reference with a priority date if a certified translation of the priority document is supplied to the U.S. Patent and Trademark Office. Such a certified translation of Japanese application number 2000-220116 is herewith attached to this amendment. Therefore, the priority date is established as July 21, 2000 which is before the filing date of Urabe et al. Thus, Urabe et al. may not be used as prior art.

Therefore, withdrawal of the rejection of Claims 2-3, 6-9, 11-12 and 14-20 under 35 USC '103(a) as being unpatentable over Urabe is respectfully requested.

Conclusion

In view of the aforementioned amendments and accompanying remarks, the claims are in condition for allowance, which action, at an early date, is requested.

~~If, for any reason, it is felt that this application is not now in condition for allowance,~~ the Examiner is requested to contact Applicants undersigned attorney at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "**Version with markings to show changes made**."

In the event that this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. Please charge any fees for such an extension of time and any other fees which may be due with respect to this paper, to Deposit Account No. 01-2340.

Respectfully submitted,
ARMSTRONG, WESTERMAN & HATTORI, LLP

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GNS/alw

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DECLARATION

I, Hironobu KAZUHARA, residing at Matsugasaki 219-8, Kashiwa-shi, Chiba-ken, Japan, do hereby declare that I am familiar with the English and Japanese languages and that the annexed document in the English language is a full and faithful translation, prepared by me, of the certified copy of the Japanese Patent Application No. 2000-220116 filed July 21, 2000.

Dated this 15th day of April, 2003

Hironobu KAZUHARA

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JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy of the following application as filed with this Office.

Date of Application: July 21, 2000

Application Number: Patent Application No. 2000-220116

Applicant: CITIZEN WATCH CO., LTD.

August 17, 2001

Commissioner,
Patent Office

Kozo OIKAWA (Sealed)

Certified Number 2001-3073050

[Name of Document]	Patent Application
[Case Number]	P-25256
[Filing Date]	July 21, 2000
[Addressee]	Commissioner of Patent Office Kozo OIKAWA
[International Patent Classification]	G02F 1/1335
[Title of the Invention]	TRANSFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE

[Inventor]

[Address or residence]	c/o Citizen Watch Co., Ltd. Technical Laboratory, 840, Aza-Takeno, Oaza Shimotomi, Tokorozawa-shi, Saitama
[Name]	Yasushi KANEKO

[Applicant for Patent]

[Code Number]	000001960
[Name or corporation name]	CITIZEN WATCH CO., LTD.
[Representative]	Hiroshi HARUTA
[Telephone Number]	03-3342-1231

[Indication of Charge]

[Prepayment Table Ledger Number]	003517
[Amount of Payment]	21,000

[List of Filed Documents]

[Name of Document]	Specification	1
[Name of Document]	Drawing	1
[Name of Document]	Abstract	1

[Confirmation of Proof] Proof Necessary

[NAME OF DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] TRANSFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE

[CLAIMS]

[Claim 1] A transflective liquid crystal display device characterized in that a transflective layer having transparent portions formed by means of anodic oxidation is installed on an inside of a liquid crystal element composed of liquid crystal sandwiched between a pair of substrates.

[Claim 2] A transflective liquid crystal display device characterized in comprising a liquid crystal element composed of twisted nematic liquid crystal sandwiched between a first substrate having a transflective layer having transparent portions formed by means of anodic oxidation and a first electrode and a second substrate having a second electrode, a first optical compensatory element disposed outside the second substrate, a first polarizing film, a second optical compensatory element disposed outside the first substrate, a second polarizing film, and a backlight disposed outside the second polarizing film.

[Claim 3] A transflective liquid crystal display device according to claim 2, characterized in using the nematic liquid crystal having a twist angle in a range of 180 to 260°.

[Claim 4] A transflective liquid crystal display device according to claim 2, characterized in that a scattering layer is installed on an outside of the second substrate of the liquid crystal element.

[Claim 5] A transflective liquid crystal display device according to claim 2, characterized in that the first optical compensatory element is composed of one sheet of retardation film, or a plurality of sheets of retardation films.

[Claim 6] A transflective liquid crystal display device according to claim 2, characterized in that the first optical compensatory element is composed of a twisted retardation film.

[Claim 7] A transflective liquid crystal display device according to claim 2, characterized in that the first optical compensatory element is composed of a twisted retardation film, and one sheet of retardation film or a plurality of sheets of retardation films.

[Claim 8] A transflective liquid crystal display device according to claim 2, characterized in that color filters in a plurality of colors are installed on either the first substrate or the second substrate of the liquid crystal element.

[Claim 9] A transflective liquid crystal display device according to claim 1 or 2, characterized in that the transparent portions installed on the transflective layer are provided for every pixels and a ratio of the transparent potions to the untransparent portion is in a range of 5 to 30%.

[Claim 10] A transflective liquid crystal display device according to claim 1 or 2, characterized in that the transparent portions installed on the transflective layer are formed in a slit shape for every pixels in succession, and a ratio of the transparent potions to the untransparent portion is in a range of 5 to 30%.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[TECHNICAL FILED OF THE INVENTION]

The present invention relates to a liquid crystal display device, and in particular, to a single polarizing film reflection type liquid crystal display device composed of a reflector inside a liquid crystal element thereof and one

sheet of polarizing film, capable of effecting bright display in black and white or in color.

[0002]

[BACKGROUND TECHNOLOGY]

For a conventional reflection-type liquid crystal display device, there is in use mainly a reflection-type liquid crystal display device of a constitution wherein a TN (twisted nematic) liquid crystal element or an STN (super-twisted nematic) liquid crystal element is disposed between a pair of polarizing films, and a reflective layer is installed on the outside of one of the polarizing films. However, in this system, brightness is deteriorated and since the reflective layer is installed on the outside of a glass substrate, there arises a problem that shadows come to appear on display.

[0003]

To cope with the foregoing problem, a single polarizing film reflection type liquid crystal display device, capable of effecting display with just one sheet of polarizing film, has been proposed. Since there is one sheet of polarizing film, brightness can be improved in comparison with the conventional reflection-type liquid crystal display device employing the two sheets of the polarizing films. Further, with the single polarizing film-type liquid crystal display device, the problem of the shadows appearing on display can be solved by forming a reflective layer inside a liquid crystal element.

[0004]

Such a single polarizing film-type liquid crystal display device is composed of one sheet of polarizing film, one sheet of retardation film, and a liquid crystal element incorporating a reflective layer, as disclosed in, for example, JP, H4 - 97121, A. Further, a single polarizing film-type liquid crystal display device employing an optical compensatory element having a

structure twisted in the direction opposite to the twist direction of a liquid crystal layer in place of a retardation film is also disclosed in, for example, JP, H10 -123505, A.

[0005]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

With such conventional single polarizing film-type liquid crystal display devices as described above, however, it is not possible to install a backlight because the reflective layer does not allow light to pass therethrough, so that it has not been possible to see display at places where external light is dim or at night.

[0006]

Accordingly, there has been developed a transflective liquid crystal display device, employing a transflective layer serving as a half-mirror, made up of a very thin aluminum film with thickness in a range of 0.01 to 0.03 μm, formed by the vapor deposition method or the sputtering method as a reflective layer, or employing a transflective layer provided with an opening for every pixel by use of photoetching method as a reflective layer. As a result, display can be effected by lighting up a backlight at places where external light is dim or at night.

[0007]

However, in the case of using a thin metal film for the half-mirror, since significant variation in transmittance of the transflective layer occurs depending on the thickness thereof, and there will be an increase in fluctuation of transmittance as well as reflectance of the transflective layer at the time of production, there is a drawback in that large dispersion will occur in brightness of the liquid crystal display device and in luminance of backlight.

[0008]

Although a liquid crystal display device employing a reflective layer provided with an opening for every pixel has been disclosed in, for example, JP, H10 - 282488, A, in the case of the type of the reflective layer provided with the opening, cell gaps which are gaps between liquid crystal elements are different in the opening and non-opening by a thickness of the reflective layer in a range of 0.1 to 0.2μm, and hence it is difficult to control the cell gaps and display unevenness tends to occur in an STN (super twisted nematic) liquid crystal element for controlling the cell gaps strictly.

[0009]

Further, according to the STN liquid crystal element, there occurs an alignment defect caused by a difference in cell gaps and unevenness in rubbing process and domain generated during driving.

[0010]

It is therefore an object of the invention to solve the problems of the prior art and to provide a single polarizing film transflective liquid crystal display device capable of effecting reflective display utilizing external light and transmissive display by backlighting, and having less display unevenness and less alignment defect with little fluctuation in display brightness.

[0011]

[MEANS FOR SOLVING PROBLEMS]

To achieve the above object, the transflective liquid crystal display device of the present invention is characterized in that a transflective layer having transparent portions formed by means of anodic oxidation is installed on an inside of a liquid crystal element composed of liquid crystal sandwiched between a pair of substrates.

[0012]

Further, the transflective liquid crystal display device of the present invention is characterized in comprising a liquid crystal element composed of twisted nematic liquid crystal sandwiched between a first substrate having a transflective layer having transparent portions formed by means of anodic oxidation and a first electrode and a second substrate having a second electrode, a first optical compensatory element disposed outside the second substrate, a first polarizing film, a second optical compensatory element disposed outside the first substrate, a second polarizing film, and a backlight disposed outside the second polarizing film.

[0013]

Still further, the liquid crystal element composed of twisted nematic liquid crystal having a twist angle preferably in a range of 180 to 260° is used. Or a scattering layer may be installed on an outside of the second substrate of the liquid crystal element.

[0014]

[EMBODIMENTS FOR CARRYING OUT THE INVENTION]

An optimal construction and operation of a transflective liquid crystal display device for carrying out the present invention are described hereinafter with reference to the accompanying drawings. Fig. 1 is a schematic sectional view showing a constitution of the transflective liquid crystal display device of the present invention, Fig. 2 is a plan view enlarging pixel portion of the liquid crystal display device of the present invention, Fig. 5 is a sectional view of a substrate used in the liquid crystal display device of the present invention, and Fig. 6 is a sectional view of a substrate used in a conventional liquid crystal display device.

[0015]

A first substrate used in a conventional liquid crystal display device is

provided with a transflective layer 7, and an opening 29 is provided in pixel portions where a first electrode and a second electrode cross and no transflective layer is formed in the opening 29 as shown in Fig. 6. A thickness of the transflective layer 7 generally in the order of 0.1 to 0.2 μm, and even after a planarization treatment is applied thereto by a protective film 8, the surface of the protective film 8 is left with differences in level of 0.05 μm or more. Due to the differences in level, there occurs a difference of 0.05 μm or more between cell gaps serving as gaps between the first substrate 1 and a second substrate 2 at the respective openings 29 and non-opening, so that display unevenness, and in the worst case, alignment defect have occurred, thereby degrading display quality considerably. Particularly, in the case of using an STN liquid crystal element having a twist angle in a range of 180 to 260°, due to the difference between the cell gaps, alignment defect has occurred by the induction domain typical of STN liquid crystal during a period of applying a driving voltage.

[0016]

Accordingly, the first substrate used in the liquid crystal display device of the present invention has transparent portions 9 formed on the transflective layer 7, as shown in Fig. 5, and light emitted from the backlight is transmitted through the transparent portions 9. The transparent portions 9 are formed substantially in the same thickness by subjecting aluminium serving as the material of the transflective layer 7 to an anodic oxidation, and planarization treatment is applied by the protective film 8, the surface becomes flat. Since a difference in level is not produced between the transparent portions 9 and transflective layer 7, there does not occur display unevenness and alignment defect, so that excellent image quality is obtained, thereby providing the single poralizing film transflective liquid crystal display

device capable of obtaining reflective display utilizing external light, and bright display in good contrast by backlighting at the environment having less external light.

[0017]

The transflective liquid crystal display device of the present invention is characterized in that the transflective layer having the transparent portion is installed on the inside of the liquid crystal element. As shown in Fig. 1, the liquid crystal element is provided with a transflective layer 7, transparent portions 9, and protective film 8 over the transparent portions 9, and further includes a first substrate 1 on which a first electrode 3 is formed, a second substrate 2 on which a second electrode 4 is formed, a sealant 5 for bonding the first substrate 1 and the second substrate 2, and a twisted nematic liquid crystal 6 which is sandwiched between the first substrate 1 and the second substrate 2.

[0018]

As shown in Fig. 1, the liquid crystal display device of the present invention can be composed of a twisted retardation film 12, a first retardation film 13, and a second retardation film 14, which constitute a first optical compensatory element disposed over a liquid crystal element 20 and a first polarizing film 11, and a third retardation film 18 which is a second optical compensatory element, a second polarizing film 17, and a backlight 16 or the like, which are disposed under the liquid crystal element 20. Further, a scattering layer 15 may be provided at the second substrate.

[0019]

As shown in Fig. 2, a portion where the first electrode 3 and the second electrode 4 cross each other form pixels. Rectangular transparent portions 9 formed by means of anodic oxidation are provided on central

portions of the pixels, and the transflective layer 7 is formed so as to surround the respective transparent portions 9. The greater an area of the transparent portions 9, the brighter display becomes when the backlight is lit up, but conversely, display becomes darker at the time of reflective display. The transflective layer 7 having different area ratios of the respective transparent portions 9 was prepared on a trial basis, and evaluation was made, whereupon it has turned out that an area ratio of the transparent portions 9 in a range of 5 to 30% is preferable, and the area ratio in a range of 10 to 25% is more preferable. For example, if the area ratio of the transparent portions 9 is 20%, it follows that the liquid crystal element 20 allows about 20% of light to pass therethrough, reflecting remaining 80% of light.

[0020]

A liquid crystal display device having such a constitution as described is called a transflective type, and is capable of effecting both reflective display utilizing external light and transmissive display by use of the backlight 16. First, reflective display is described hereinafter. External light enters through the first polarizing film 11 and is turned into the linearly polarized light, and is transmitted through the twisted retardation film 12, the first retardation film 13, and the second retardation film 14, composing the first optical compensatory element, so as to be turned into circularly polarized light after passing further through portions of the liquid crystal layer 6. The circularly polarized light undergoes a change in phase by 180° when reflected by the transflective layer 7, and is reflected as reverse-handed circularly polarized light. Thereafter, after passing again through the liquid crystal layer 6, the twisted retardation film 12, the first retardation film 13, and the second retardation film 14, the reverse-handed circularly polarized light is turned into linearly polarized light with a direction of polarization rotated

through 90° from that of incident light, thereby effecting black display.

[0021]

When a voltage is applied to the liquid crystal layer 6, liquid crystal molecules thereof are caused to rise, and the birefringent tendency of the liquid crystal layer 6 is reduced by an extent equivalent to a quarter wavelength, so that total retardation of the liquid crystal layer 6 and the first optical compensatory element is substantially eliminated. The linearly polarized light which has entered through the first polarizing film 11 arrives at the transflective layer 7 in a state of linearly polarized light, and is again transmitted through the liquid crystal layer 6 and the first optical compensatory element composed of the twisted retardation film 12, the first retardation film 13, and the second retardation film 14, and is turned into a linearly polarized light in the direction identical to that of the incident light, thereby effecting white display.

[0022]

Next, transmissive display by use of the backlight is described. The retardation value of the third retardation film 18 is set to be substantially equivalent to a total retardation value obtained by the twisted retardation film 12, the first retardation film 13, the second retardation film 14, and the portions of the liquid crystal layer 6 and these constituent members are disposed at angles such that the respective retardation values described above are subtracted from that of the third retardation film 18. That is, a total retardation value from the third retardation film 18 to the second retardation film 14 is nearly zero.

[0023]

Light emitted from the backlight 16 passes through the second polarizing film 17 and is turned into the linearly polarized light, and passes

through the third retardation film 18, subsequently passing through the transparent portions 9 of the transflective layer 7. The linearly polarized light, even after passing through from the third retardation film 18 to the second retardation film 14, has no retardation value, and hence it arrives as it is at the first polarizing film 11. If the angle of disposition of the first polarizing film 11 and that of the second polarizing film 17 are orthogonal to each other, light emitted from the backlight 16 is intercepted, thereby effecting black display.

[0024]

When a voltage is applied to the liquid crystal layer, liquid crystal molecules thereof are caused to rise, and a retardation value comes to be provided between the third retardation film 18 and the second retardation film 14. The linearly polarized light, transmitted through the second polarizing film 17 is turned into elliptically polarized light and arrives at the first polarizing film 11, passing therethrough, thereby effecting white display.

[0025]

[EMBODIMENTS]

(First Embodiment: Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5)

The constitution and effect of the present invention are explained hereinafter with reference to embodiments of the liquid crystal display device of the present invention. First of all, the constituents of the liquid crystal display device according to the first embodiment of the present invention is described with reference to drawings. Fig. 1 is a sectional view for explaining constituents of the liquid crystal display device according to the first embodiment of the present invention, Fig. 2 is a plan view enlarging pixel portions, Fig. 3 and Fig. 4 are plan views showing relation of arrangement of the constituents, and Fig. 5 is a sectional view enlarging a first

substrate. The constitution of the transflective liquid crystal display device of the present invention is explained hereinafter with reference to Fig. 1 to Fig. 5.

[0026]

As shown in Fig. 1, the liquid crystal display device according to the first embodiment is composed of a liquid crystal element 20, a twisted retardation film 12, a first retardation film 13, and a second retardation film 14, which constitute a first optical compensatory element disposed over the liquid crystal element 20 and a first polarizing film 11 provided on the first optical compensatory element, and a third retardation film 18 which is a second optical compensatory element, a second polarizing film 17, and a backlight 16, which are installed on the underside of the liquid crystal element 20.

[0027]

The first polarizing film 11, the second retardation film 14, the first retardation film 13, and the twisted retardation film 12 are integrally joined together with an acrylic adhesive, and it is bonded to the liquid crystal element 20 with an acrylic adhesive. Further, the second polarizing film 17 and the third retardation film 18 are also integrally joined together with an acrylic adhesive, and it is bonded to the liquid crystal element 20 with an acrylic adhesive.

[0028]

The liquid crystal element 20 comprises the transflective layer 7 made up of aluminium 0.1 μm thick having scattering property, the protective film 8 made up of acrylic material 2 μm thick, the first substrate 1 made up of glass sheet 0.5 mm thick provided with the first electrode 3 made of ITO serving as a transparent electrode material, a second substrate 2 made up of a

~~serving as a transparent electrode material, a second substrate 2 made up of a~~ transparent glass sheet 0.5 mm thick, and provided with the second electrode 4 made up of ITO, a sealant 5 for bonding the first substrate 1 and the second substrate 2, and nematic liquid crystal 6 twisted 240° counterclockwise which are held between the first substrate 1 and the second substrate 2.

[0029]

As shown in Fig. 2, crossover points of the first electrodes 3 and the second electrodes 4 constitute respective pixels, and the transflective layer 7 is formed at the peripheral part of the respective pixels. The transflective layer 7 is provided with transparent portions 9 rectangular in shape, each formed at positions corresponding to the center of the respective pixels. Further, on the surface of the transflective layer 7, there are provided pits and projections at a pitch ranging from several μm to several tens of μm, thereby rendering to form a scattering reflection layer. With the transflective layer 7 having the scattering reflection layer, excellent display can be effected with hardly any defocus of characters which is dependent on scattering of light.

[0030]

For the transparent portions 9, an aluminium film of 0.1 μm thick is formed by sputtering method on the first substrate 1 to which pits and projections are applied, and photoresist is applied onto the aluminum film, and dried, thereafter, the openings are provided in the photoresist by applying exposure and development treatments thereto using a photomask, then, anodic oxidation is carried out in diluted solution of ammonium phosphate by applying a voltage in a range of 50 to 100V, and thereby only portions of the aluminum film, corresponding to the respective openings of the photoresist, are subjected to anodic oxidation, being turned into a transparent aluminum oxide film. Subsequently, upon removal of the photoresist, there is obtained

the transflective layer 7 provided with the transparent portions 9 rectangular in shape. Thereafter, the anodic oxidation is again carried out by applying low voltage in a range of 10 to 20V so as to protect the surface of the aluminium film, thereby forming a thin oxide film at the portion other than the transparent portions 9. With the present embodiment, about 20% was adopted as the area ratio of the respective transparent portions 9, so that reflective display became bright at the time of reflection, and excellent image quality was also obtained at the time of transmissive display by backlighting.

[0031]

For the twisted retardation film 12, use is made of a film obtained by applying a polymer of liquid crystallinity having a twist structure to a triacetylcellulose (TAC) film or a polyethylene terephthalate (PET) film to which an alignment treatment has been applied, adjusting a twist angle thereof after turning the same into a liquid crystal state by heating at a high temperature on the order of 150°C, and subsequently, rapidly cooling the same to room temperature, thereby fixing a twisted condition thereof.

[0032]

Otherwise, use may be made of a film formed by applying a polymer of liquid crystallinity to a film for use in alignment to which an alignment treatment has been applied, and subsequently, transferring the polymer of liquid crystallinity from the film for use in alignment to a TAC film prepared separately, after fixing a twisted condition thereof. With the present embodiment, use is made of the twisted retardation film 12 twisted clockwise, having a twist angle Tc of -240°, and Rc of 0.80 μm, which is Δnd value indicating birefringent tendency.

[0033]

The first polarizing film 11 is preferably as bright as possible, and has

a high degree of polarization. With the present embodiment, the polarizing film having a transmittance of 45% and a degree of polarization of 99.9% is employed. If a non-reflection layer having reflectance on the order of 0.5% is formed by coating the surface of the first polarizing film 11 with inorganic thin films in a plurality of layers, each having a different refractive index, by the vapor deposition method or the sputtering method, a surface reflectance of the first polarizing film 11 becomes lower and a transmittance thereof is enhanced, and hence, display becomes brighter, and contrast is improved because a blackness level is lowered.

[0034]

The first retardation film 13 is a transparent film of about 70 μm thick, formed by drawing polycarbonate (PC), and has a retardation value F1 of 0.14 μm at a wavelength of 0.55 μm, equivalent to a quarter-wavelength. The second retardation film 14 is also a transparent film of about 70 μm thick, formed by drawing polycarbonate, and is set to have a retardation value F2 of 0.28 μm at a wavelength of 0.55 μm, equivalent to a half-wavelength.

[0035]

The third retardation film 18 is also a transparent film of about 70 μm thick, formed by drawing polycarbonate, and has a retardation value F3 of 0.14 μm at a wavelength of 0.55 μm, which is a quarter-wavelength plate. It is important that the second polarizing film 17 has a high degree of polarization, and employs a material having a transmittance of 44% and a degree of polarization of 99.99%.

[0036]

For the backlight 16, although an optical guide sheet with a fluorescent lamp or an LED attached thereto, an electroluminescence (EL) sheet and so forth can be used, with the present embodiment, however, an EL

sheet of about 1 mm thick emitting white light is employed.

[0037]

Next, the relation of configuration among respective constituent members is explained with reference to Fig. 3 and Fig. 4. Fig. 3 shows the variation of a configuration between the liquid crystal element 20 and the constituent members disposed on the underside of the liquid crystal element 20, and Fig. 4 shows the relation of a configuration between the constituent members disposed on the topside of the liquid crystal element 20. An alignment film (not shown) is formed on the surface of the first electrodes 3 and the second electrodes 4, and as shown in Fig. 3, an alignment direction 6a of liquid crystal molecules in the lower part points at +30° by applying a rubbing treatment in a direction extending upward to the right at 30° relative to the horizontal axis H on the side of the first substrate 1, while an alignment direction 6b of liquid crystal molecules in the upper part points at -30° by applying a rubbing treatment in a direction extending downward to the right at 30° relative to the horizontal axis H on the side of the second substrate 2. An optical rotatory substance called chiral is added to the nematic liquid crystal having viscosity at 20 cp, and a twist pitch P thereof is adjusted to be at 11 μm, thereby constituting the STN mode liquid crystal element 20, having a twist angle Ts of 240° counterclockwise.

[0038]

A refractive index difference Δn of the nematic liquid crystal 6 in use is 0.15, and a cell gap d, that is, a gap between the first substrate 1 and the second substrate 2, is set at 5.6 μm. Accordingly, if a value to indicate birefringent tendency of the liquid crystal element 20 as expressed by Δnd, that is, the product of the refractive index difference Δn of the nematic liquid crystal 6 and the cell gap d, is designated Rs, the value Rs is 0.84 μm.

[0039]

A first transmission axis 11a of the first polarizing film 11 is disposed, as shown in Fig. 4, at an angle of +45° on the basis of the horizontal axis H. An alignment direction 12a of molecules in the lower part of the twisted retardation film 12 is disposed at an angle of +60° on the basis of the horizontal axis H, and an alignment direction 12b of molecules in the upper part thereof is at an angle of -60°, so that a twist angle Tc thereof becomes -240° clockwise, and if a difference in absolute value between the twist angles is designated by ΔT, $\Delta T = | Ts | - | Tc | = 0°$. If a refractive index difference is designated ΔR, $\Delta R = Rs - Rc = 0.04$ μm, substantially equivalent in value.

[0040]

A phase delay axis 13a of the first retardation film 13 is disposed at an angle of -30° relative to the horizontal axis H, and a phase delay axis 14a of the second retardation film 14 is disposed at an angle of +30° relative to the horizontal axis H. By disposing two sheets of the retardation films such that an intersection angles formed by respective phase delay axes becomes 60°, a retardation value made up by the two sheets of the retardation films becomes 0.14 μm at a wavelength of 0.55 μm, smaller than 0.14 μm for light at a wavelength shorter than that, and greater than 0.14 μm for light at a wavelength longer than that, and hence, there is made up the so-called broad band quarter-wave plate wherein a relation represented by retardation value / wavelength = 1 / 4 applies to all wavelength regions, and the effective optical axis thereof is in the direction of the horizontal axis H.

[0041]

As shown in Fig. 3, a phase delay axis 18a of the third retardation film disposed on the underside of the liquid crystal element 20 is disposed so as to be orthogonal to the horizontal axis H, and a transmission axis 17a of the

second polarizing film 17 is disposed at an angle of -45° relative to the horizontal axis H so as to cross the transmission axis 11a of the first polarizing film 11 at right angles.

[0042]

Since the operation principle of the liquid crystal display device of the present embodiment at the time of reflection and at the time of transmittance of light has been already explained, it is omitted. Next, the effect of the transparent portions 9 is briefly described again. The first substrate 1 used in the liquid crystal display device according to the present embodiment has, as shown in Fig. 5, the transparent portions 9 formed in the transflective layer 7. The transparent portions 9 are made up of an aluminum oxide film formed by applying anodic oxidation to aluminum, of which the transflective layer 7 is made up, and have substantially the same thickness as that of the transflective layer 7. By applying a planarization treatment to the transflective layer 7 with the protective film 8, the surfaces of these portions become completely flat. Accordingly, the cell gap of the liquid crystal element 20 becomes uniform, and display unevenness and alignment defect, which have occurred in the conventional liquid crystal display device provided with openings, have not occurred, thereby obtaining excellent image quality.

[0043]

In such a manner, display in good contrast can be effected in the case of reflective display utilizing external light by the agency of the first polarizing film 11, the first optical compensatory element, and the liquid crystal element 20 incorporating the transflective layer 7 provided with the transparent portions 9, further, because the second optical compensatory element, the second polarizing film 17, and the backlight 16 are installed on the underside of the liquid crystal element 20, excellent transmissive display

can be effected by lighting up the backlight 16 in an environment where external light is insufficient, and furthermore, it was possible to provide the single polarizing film transflective liquid crystal display device having little display unevenness, and insusceptible to occurrence of alignment defect.

[0044]

With the present embodiment, the STN mode liquid crystal element having a twist angle of 240° is employed for the liquid crystal element 20, however, it is possible to provide a similar transflective liquid crystal display device which is made up even by use of a TN liquid crystal element having a twist angle of around 90°. In the case of effecting display on a large screen by employing the TN liquid crystal element, an active matrix reflective liquid crystal display device incorporating active elements such as TFTs or MIMs is preferably adopted.

[0045]

With the present embodiment, a film made of a polymer of liquid crystallinity with the twisted condition thereof fixed at room temperature is used for the twisted retardation film 12, however, with the use of a temperature compensatory twisted retardation film wherein parts of liquid crystal molecules are simply bonded to chain polymer molecules, having Rc varying in value depending on temperature, brightness and contrast are improved at high and low temperatures, so that a better transflective liquid crystal display device can be obtained.

[0046]

With the present embodiment, a thin aluminum film is used for the transflective layer 7, however, a thin film made of metal, such as an aluminum alloy, silver can be used instead, and further, in order to improve reflectance and to protect the surface thereof, a multilayer film made of an

inorganic oxide may be formed on the surface of the aluminium film after the formation of the transparent portions.

[0047]

With the present embodiment, the transflective layer 7 is installed separately from the first electrodes 3, however, the first electrodes may be made up of the thin film made of metal, such as an aluminum alloy, silver, so as to function as reflective electrodes doubling as the transflective layer 7, thereby simplifying the construction of the liquid crystal element. Further, a similar effect can be obtained by installing the transflective layer 7 on the outside of the first substrate 1 although shadows occur on the display.

[0048]

Further, with the present embodiment, by use of the first substrate 1 having the surface to which the treatment for providing pits and projections is applied, the transflective layer 7 having scattering property is formed on the surface of the first substrate 1, however, it is also possible to form the transflective layer 7 having scattering property by applying a photosensitive protection film on top of the first substrate 1, forming a layer having in a desired shape by photo-etching treatment, and forming a thin aluminum film thereon. Still further, a similar effect can also be obtained by directly applying a protective film with fine particles mixed therein onto the transflective layer 7.

[0049]

(Second Embodiment: Fig. 7, Fig. 8, Fig. 9, Fig. 10)

Next, the constitution of the transflective liquid crystal display device according to the second embodiment of the present invention is explained. The liquid crystal display device of the present embodiment is different from the constitution of the first embodiment in that the first optical compensatory

element is made up of only one sheet of a twisted retardation film, a scattering layer is installed on the outside of a second substrate, a second optical compensatory element is made up of a third retardation film and a fourth retardation film, and also a color filter is provided for enabling color display.

[0050]

The transflective liquid crystal display device of the present embodiment is explained with reference to drawings. Fig. 7 is a sectional view for explaining constituents of the liquid crystal display device according to the present embodiment, Fig. 8 is a plan view enlarging pixel portions, Fig. 9 and Fig. 10 are plan views showing relation of arrangement of the constituents. The constitution of the transflective liquid crystal display device of the present invention is explained hereinafter with reference to Fig. 7 to Fig. 10.

[0051]

As shown in Fig. 7, the transflective liquid crystal display device according to the second embodiment is composed of a liquid crystal element 21, a light scattering layer 15 installed on the upper side of the liquid crystal element 21, a twisted retardation film 12 which is a first optical compensatory element, and a first polarizing film 11, a third retardation film 18 and a fourth retardation film 19 composing a second optical compensatory element, a second polarizing film 17, and a backlight 16, which are installed on the underside of the liquid crystal element 21.

[0052]

The first polarizing film 11 and the twisted retardation film 12 are integrally joined together with an acrylic adhesive, and the twisted retardation film 12 is bonded to the liquid crystal element 21 with a light scattering adhesive layer used as the light scattering layer 15. Further, the third

retardation film 18, the fourth retardation film 19, and the second polarizing film 17 are also integrally joined together with an acrylic adhesive, and the third retardation film 18 is bonded to the liquid crystal element 21 with an acrylic adhesive.

[0053]

For the liquid crystal element 21, there are installed the transflective layer 7 made up of an aluminum film of 0.1 μm thick, a color filter 10 of 1 μm thick, made up of color filters in three colors , that is, red filters R, green filters G, and blue filters B, a protective film 8 of 2 μm thick made of an acrylic material, a first substrate made up of glass sheet of 0.5 mm thick on which first electrodes 3 of 0.3 μm thick made of ITO is formed, a second substrate 2 made up of a glass sheet of 0.5 mm thick on which second electrodes 4 of 0.05 μm thick made of ITO is formed, a sealant 5 for bonding the first substrate 1 and second substrate 2 and nematic liquid crystal 6 twisted 240° counterclockwise held between the first substrate 1 and the second substrate 2.

[0054]

Because the transflective layer 7 according to the present embodiment is formed without applying a treatment for providing pits and projections to the first substrate, it is like a mirror. Accordingly, incident light undergoes regular reflection instead of being reflected to the visual recognition direction, raising the possibility of causing dark display, and hence the light scattering layer 15 is installed on the outside of the liquid crystal element 21. The transflective layer 7 provided with transparent portions 9 made of aluminum oxide, formed by means of anodic oxidation, each formed in a slit shape, as shown in Fig. 8. An area of the transparent portions 9 is set to be equivalent to 20% of the total area of the transflective layer.

[0055]

The color filter 10 is made up of the color filters in three colors, namely, the red filters R, the green filters G, and the blue filters B, and with the present embodiment, the filters in the respective colors are formed in longitudinal stripes parallel with the second electrodes 4, respectively, as shown in Fig. 8. The color filters are formed to have a width wider than that of the respective second electrodes 4 such that no gap occurs therebetween. If there occurs a gap between the color filters 10, display will become brighter due to an increase in quantity of incident light, however, this is undesirable because a white light color is mixed in a color displayed, thereby degrading color purity.

[0056]

In order to improve brightness, the maximum transmittance of the color filter 10 for a spectrum is preferably as high as possible, and the maximum transmittance of the filters in the respective colors of 80% or more, is preferable, the same of 90% or more being most preferable. Further, the minimum transmittance thereof for a spectrum needs to be rendered to be as high as 20 to 50%.

[0057]

For the color filter 10, use can be made of a color filter of a pigment-suspended type, a dyed type, a printed type, a transfer type, an electrodeposition type, and so forth, however, the color filter of the pigment-suspended type, wherein pigment is kept in suspension in acrylic or PVA photosensitive resin, is most preferable because of its high heat resistant temperature and excellent color purity.

[0058]

In order to obtain the color filters having such a high transmittance as

described above, it is preferable to form the transflective layer 7 made up of a thin aluminum film on the first substrate 1, to form the transparent portions 9 in the transflective layer 7 by means of anodic oxidation, and subsequently, to form a thin oxide layer of aluminum oxide on the entire surface as well by applying anodic oxidation again at a voltage in a range of 10 to 20V for protection of aluminum in the course of a cleaning process and so forth. The color filter 10 on the order of 1 μm in thickness, having a high transmittance, can be formed by applying a color resist prepared by mixing 10 to 15% of pigment with a photosensitive resin to the first substrate 1 by use of a spinner, and by carrying out exposure and development processes.

[0059]

For the first polarizing film 11 and the second polarizing film 17, the same material as that used in the case of the first embodiment is used. The twisted retardation film 12 has a twist angle Tc of 180°, and Rc of 0.68 μm, which is Δnd value. For the light scattering layer 15 which is a light scattering adhesive layer formed of an acrylic adhesive with light scattering fine particles mixed therein, EDA -1 (trade name) is used.

[0060]

The third retardation film 18 is the same as that used in the first embodiment, and has a retardation value F1 of 0.14 μm, equivalent to a quarter wavelength, while the fourth retardation film 19 is also a transparent film of about 70 μm thick, formed by drawing PC, and is set to have a retardation value F2 of 0.28 μm for light at a wavelength of 0.55 μm, equivalent to a half wavelength. By employing these two sheets of the retardation films, a broad band quarter-wavelength plate is constituted in the same manner as the constitution used in the first optical compensatory element of the first embodiment.

[0061]

For the backlight 16, an EL sheet emitting white light may be employed as with the case of the first embodiment, however, with the present embodiment, a side light type backlight which is an optical guide sheet with a white LED (light emitting diode) attached thereto is employed in order to lower power consumption and to enhance brightness.

[0062]

Next, the relation of configuration among respective constituent members of the liquid crystal display device is described hereinafter with reference to Figs. 9 and 10. Fig. 9 shows the relation of configuration between the liquid crystal element 21 and the constituent members disposed on the underside of the liquid crystal element 21, and Fig. 10 shows the relation of configuration of the constituent members disposed on the topside of the liquid crystal element 21. Since the relation of a configuration of the liquid crystal element 21 is the same as that of the first embodiment, the explanation thereof is omitted.

[0063]

A refractive index difference Δn of the nematic liquid crystal 6 in use is 0.15, and a cell gap d, that is, a gap between the first substrate 1 and the second substrate 2, is set at 5.4 μm. Accordingly, a value Rs to indicate birefringent tendency of the liquid crystal element 21 as expressed by Δnd, that is, the product of the refractive index difference Δn of the nematic liquid crystal 6 and the cell gap d, is 0.81 μm, thereby constituting a liquid crystal element 21 having a twist angle Ts of 240°.

[0064]

As shown in Fig. 10, a transmission axis 11a of the first polarizing film is disposed at an angle of -55° on the basis of the horizontal axis H.

An alignment direction 12a of molecules in the lower part of the twisted retardation film 12 is at an angle of +55° on the basis of the horizontal axis H, and an alignment direction 12b of molecules in the upper part thereof is also at an angle of +55°, so that a twist angle Tc thereof becomes 180° clockwise, and a twist angle ratio Tc / Ts is 0.75. If a refractive index difference is designated ΔR, ΔR = Rs - Rc = 0.13 μm.

[0065]

As shown in Fig. 9, a phase delay axis 18a of the third retardation film 18 is disposed at an angle of +50° on the basis of the horizontal axis H, and a phase delay axis 19a of the fourth retardation film is disposed at an angle of -70° on the basis of the horizontal axis. As a result of disposing two sheets of the retardation films in this way, these retardation films constitute a broad band quarter-wavelength plate whose effective phase delay axis is at an angle of 80° relative to the horizontal axis H. A transmission axis 17a of the second polarizing film is disposed at an angle of +35° relative to the horizontal axis H so as to cross the transmission axis 11a of the first polarizing film at right angles.

[0066]

Next, the operation principle of the present embodiment is briefly described. First, reflective display is described. With the first embodiment, the twisted retardation film, the first retardation film, and the second retardation film are employed as the first optical compensatory element, however, with the present embodiment, only the twisted retardation film 12 is employed as the first optical compensatory element. By optimizing the twist angle Tc, the Δnd value Rc, and the disposition angle of the twisted retardation film 12, however, a composite birefringent tendency of the twisted retardation film 12 and the liquid crystal layer 6 becomes equivalent to a

quarter wavelength, so that perfect black condition can be effected in a condition where no voltage is applied as with the case of the first embodiment. On the other hand, in the ON condition where a voltage is applied, white display can be effected, thereby enabling display in good contrast to be effected.

[0067]

Then, by combining the ON condition with the OFF condition for respective display pixels, color display can be effected. For example, by turning a pixel corresponding to a red filter R into the ON condition (white) while turning pixels corresponding to a green filter G and a blue filter B, respectively, into the OFF condition (black), red display can be effected.

[0068]

With the transflective liquid crystal display device according to the present embodiment, a high reflectance and a high contrast ratio of 10 or more are obtained, bright color display of high chroma can be effected even at the time of reflective display without lighting up the backlight 16.

[0069]

Next, transmissive display when the backlight 16 is lit up is explained. Light emitted from the backlight 16 is turned into the linearly polarized light by the second polarizing film 17. As previously described, the effective phase delay axis composed by the third retardation film 18 and the fourth retardation film 19 is at an angle of 80° relative to the horizontal axis H, and the transmission axis 17a of the second polarizing film is disposed at an angle of + 35° relative to the horizontal axis, and hence, the linearly polarized light enters at an angle of 45° relative to the effective phase delay axis, and is turned into circularly polarized light. About 80% of the circularly polarized light is reflected by the transflective layer 7, but remaining 20% thereof

passes through the transparent portions 9.

[0070]

In a state where no voltage is applied to the liquid crystal element 21, composite birefringent tendency by the twisted retardation film 12 and the liquid crystal element 21 is equivalent to a quarter wavelength, identical to a composite retardation value by the third retardation film 18 and the fourth retardation film 19, and these films are disposed such that the respective retardation values are subtracted from each other. Accordingly, the light passing through the transparent portions 9 reverts to the linearly polarized light which is the same in the direction of the oscillation. Since the transmission axis 11a of the first polarizing film is disposed to be orthogonal to the transmission axis 17a of the second polarizing film, transmitted light is intercepted, thus effecting black display.

[0071]

When a voltage is applied to the liquid crystal layer and liquid crystal molecules are caused to rise, a retardation value comes to be provided between the fourth retardation film 19 and the twisted retardation film 12. The linearly polarized light which enters through the second polarizing film 17 is turned into elliptically polarized light, and arrives at the first polarizing film 11, thereby effecting white display.

[0072]

Next, the effect of the transparent portions 9 is explained. Similarly to the case of the first embodiment, since the transflective layer provided with the transparent portions has flatness better than that of the conventional transflective layer provided with the openings, there is less display unevenness, and the occurrence of alignment defect is less susceptible in the STN liquid crystal mode. Furthermore, by forming the respective

transparent portions 9 in the slit shape, the width thereof can be rendered narrower than that of the respective transparent portions 9 of the transflective layer according to the first embodiment, thereby further improving flatness.

[0073]

Further, the contrast in a periphery of the pixel in one pixel somewhat deteriorates compared with the contrast in the central portion of the pixel owing to an oblique electric field. According to the shape in the first embodiment, although the contrast at the time of transmission is excellent, the contrast at the time of reflection deteriorates if the areas of the transparent portions 9 are large. However, if the transparent portions 9 are formed in the slit shape, it was possible to restrain the deterioration of the contrast of the time of reflection as illustrated in the second embodiment.

[0074]

Thus, color display in good contrast can be effected in the case of reflective display utilizing external light by the agency of the first polarizing film 11, the twisted retardation film 12, the light scattering layer 15, and the liquid crystal element 21 incorporating the transflective layer 7 provided with the transparent portions 9, and the color filter 10 and since the third retardation film 18 and the fourth retardation film 19, the second polarizing film 17, and the backlight 16 are installed on the underside of the liquid crystal element 21, excellent transmissive display can be effected by lighting up the backlight 16 in an environment where external light is insufficient, and in addition, there is less display unevenness, and alignment defect and so forth are unlikely to occur.

[0075]

With the present embodiment, one sheet of the twisted retardation film 12 is employed as the first optical compensatory element, however, the

twisted retardation film, and the first and second retardation films may be employed as with the first embodiment, or one sheet of retardation film, or a plurality of sheets of retardation films may be employed instead of employing the twisted retardation film. With a transflective liquid crystal display device similar in constitution to the present embodiment of the invention, two sheets of retardation films, namely, one having a retardation value of 0.2 μm and the other having a retardation value of 0.4 μm, were employed as a first optical compensatory element, and a transmission axis 11a of a first polarizing film was disposed at an angle of -50° relative to the horizontal axis H, whereupon bright reflective display in high contrast was effected.

[0076]

With the present embodiment, the third retardation film 18, the fourth retardation film 19, the second polarizing film 17 and the backlight 16 are installed as the second optical compensatory element, however, even if only the third retardation film 18, the second polarizing film 17 and the backlight 16 are installed as with the first embodiment, excellent color display can be effected although the contrast in the case of transmissive display somewhat deteriorates.

[0077]

Further, with the present embodiment, the color filter 10 is installed on the side of the first substrate 1, however, the color filter 10 can be formed between the second electrodes 4 and the second substrate 2, on the inner side of the second substrate 2. However, the color filter 10 is preferably installed on the side of the first substrate 1 because the protective film 8 employed for planarization of the color filter 10 can double as an insulation layer between the transflective layer 7 and the first electrodes 3.

[0078]

Still further, with the present embodiment, the color filters in three colors of red, green, and blue are used for the color filter 10, however, similar bright color display can be effected by use of color filters in three colors of cyan, yellow, and magenta.

[0079]

Furthermore, with the present embodiment, the surface of the thin aluminum film of the transflective layer 7 is inactivated by applying anodic oxidation thereto so as to withstand a cleaning line in the process of fabricating the color filter, however, after the formation of the transparent portions, a transparent oxide film composed of SiO_2, and so forth can be formed on the thin aluminum film by the sputtering method or the CVD method.

[0080]

Further, with the present embodiment, the light scattering adhesive layer made of the adhesive with the light scattering fine particles mixed therein is employed as the light scattering layer 15, however, a film type light scattering layer, a photopolymer scattering layer, and so forth may be employed instead. Still further, with the present embodiment, the light scattering layer 15 is installed between the liquid crystal element 21 and the twisted retardation film 12, however, the same may be installed anywhere between the liquid crystal element 21 and the first polarizing film 11. Nevertheless, the light scattering layer 15 is preferably installed as close to the liquid crystal element 21 as possible because there will be less defocus of characters by so doing.

[0081]

Yet further, with the present embodiment, the light scattering layer 15 is disposed on the outside of the liquid crystal element 21, however, as with

the case of the first embodiment, by use of a transflective layer having scattering property, excellent color display can be effected even without the light scattering layer installed separately.

[0082]

[EFFECT OF THE INVENTION]

As is evident from the forgoing explanation, according to the present invention, there are provided a liquid crystal element incorporating the transflective layer provided with the first polarizing film, the first optical compensatory film and the transparent portions and the second optical compensatory element and the second polarizing film and the backlight, and hence it is possible to provide the single polarization film transflective liquid crystal display device capable of effecting the reflective display by external light and transmissive display by lighting up the backlight, there is less display unevenness, and alignment defect.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1]

A sectional view showing the constituents of a transflective liquid crystal display device according to the first embodiment of the present invention;

[Fig. 2]

A plan view enlarging pixel portions of the transflective liquid crystal display device according to the first embodiment of the present invention;

[Fig. 3]

A plan view showing relation of arrangement of the constituents of the transflective liquid crystal display device according to the first embodiment of the present invention;

[Fig. 4]

A plan view showing relation of arrangement of the constituents of the transflective liquid crystal display device according to the first embodiment of the present invention;

[Fig. 5]

A sectional view of a first substrate used in the transflective liquid crystal display device of the present invention;

[Fig. 6]

A sectional view of a first substrate used in a conventional transflective liquid crystal display device;

[Fig. 7]

A sectional view for showing constituents of the transflective liquid crystal display device according to the second embodiment of the present invention;

[Fig. 8]

A plan view enlarging pixel portions of the transflective liquid crystal display device according to the second embodiment of the present invention;

[Fig. 9]

A plan view showing the relation of configuration of the transflective liquid crystal display device according to the second embodiment of the present invention; and

[Fig. 10]

A plan view showing the relation of configuration of the transflective liquid crystal display device according to the second embodiment of the present invention.

[Reference of Numerals]

1 first substrate

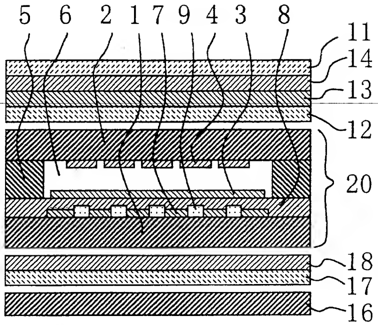
2 second substrate

3	first electrode
4	second electrode
5	sealant
6	nematic liquid crystal
6a	alignment direction of liquid crystal molecules in lower part
6b	alignment direction of liquid crystal molecules in upper part
7	transflective layer
8	protective film
9	transparent portions
10	color filter
11	first polarizing film
11a	transmission axis of first polarizing film
12	twisted retardation film
12a	alignment direction of twisted retardation film of molecules in lower part
12b	alignment direction of twisted retardation film of molecules in upper part
13	first retardation film
13a	phase delay axis of first retardation film
14	second retardation film
14a	phase delay axis of second retardation film
15	light scattering layer
16	backlight
17	second polarizing film
17a	transmission axis of second polarizing film
18	third retardation film
18a	phase delay axis of third retardation film

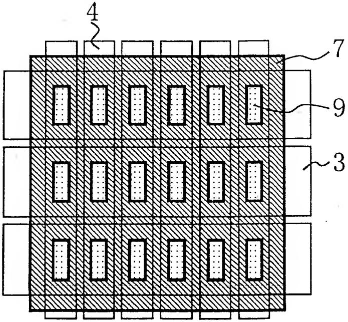
19	fourth retardation film
19a	phase delay axis of fourth retardation film
20, 21	liquid crystal element
29	openings
R	red filter
G	green filter
B	blue filter

[NAME OF DOCUMENT] DRAWINGS

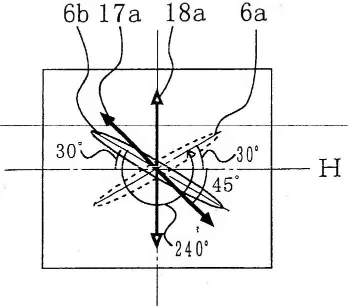
[FIG. 1]



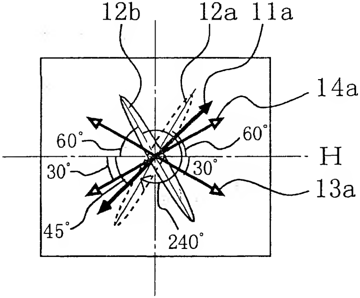
[FIG. 2]



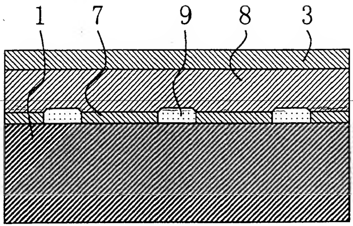
[FIG. 3]



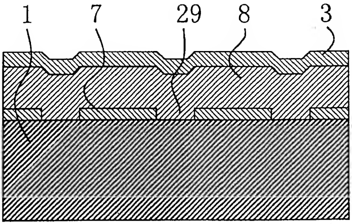
[FIG. 4]



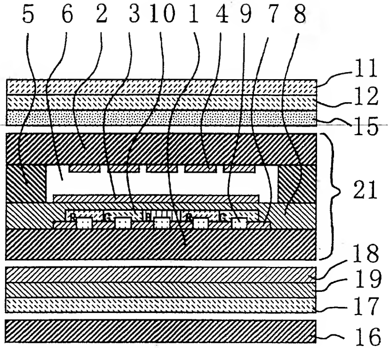
[FIG. 5]



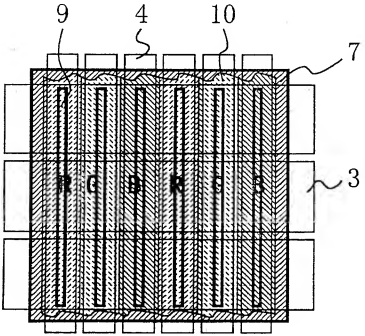
[FIG. 6]



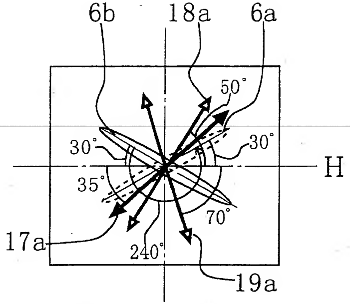
[FIG. 7]



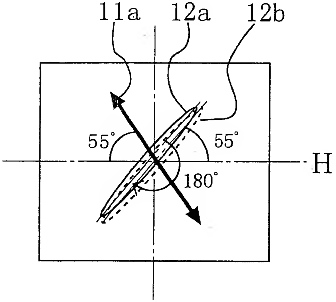
[FIG. 8]



[FIG. 9]



[FIG. 10]



[NAME OF DOCUMENT] ABSTRACT

[SUMMARY]

[PURPOSE] In a single polarizing film liquid crystal display device having one sheet of polarizing film, a transflective liquid crystal display device capable of effecting reflective display by an external light and a transmissive display by lighting up a backlight with less display unevenness and alignment defect.

[CONSTITUTION] The transflective liquid crystal display device comprising a liquid crystal element 20 incorporating a transflective layer 7 provided with a first polarizing film 11, a first optical compensatory element and transparent portions 9, a second optical compensatory element, a second polarizing film 17 and a backlight 16.

[SELECTED DRAWING] Fig. 1